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THIS IS UNEVALUATED INFORMATION

1. Supercharge systems in the USSR are classified according to the degree of compression which is represented by the relationship of the average effective pressure with supercharging "PeN" to the average effective pressure without supercharging "Pe"

$$\lambda N = \frac{PeN}{Pe}$$

2. The degree of supercharging gives the amount of increase in the specific power of the engine due to supercharging (at the same number of revolutions). The term "increased charging of the working cylinder" means the raising of the degree of the filling of the cylinder and the raising of the weight of the charge without using increased air pressure (as is obtained in special supercharge aggregates). In four-cycle engines, for example, increased charging is obtained by increasing the angle of valve recovery, thereby getting more complete burning in the combustion chamber. In two-cycle engines an additional charge can be put in the cylinder (after the exhaust port is closed) with the same exhaust air and the same pressure as that with which the exhaust process is accomplished. Increased charging makes it possible to get a higher specific power from the sequence

3. Partial supercharging is the next degree to which the cylinder power can be raised. In partial supercharging additional air is forced into the cylinder (besides the regular charge) by means of a special supercharging aggregate raising the pressure Pk = 1.2 - 1.5 KG per square CM only in that part of the piston stroke during which the charging of the cylinder takes place. The degree of supercharging reached in this system is λ_N = 1.20 - 1.40.

4. In the full supercharging system the entire cylinder charging process is done by increased air pressure 1.2-1.5 kg per square cm, by means of a special supercharging aggregate, achieving a degree of supercharging of 1.3 - 1.6 (without intermediate cooling of the supercharge air).

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5. The high full supercharge system is like that described in Paragraph 4 except that the degree of supercharge is higher, 1.6-2.5 kg per square cm. When the supercharge (or exhaust) air is cooled, the degree of supercharge reaches from 1.7 to 2.3 and higher.

6. In engines having gas piston generators all the power of the engine is used to drive the appended supercharge or exhaust-supercharge aggregate, which has an exhaust-supercharge pressure of 3-6 kg per cm, the energy of the gas-air mixture being used solely by a gas turbine of constant pressure operating on a screw propellor. In this system the degree of supercharge reaches 2.5 - 3.5.

7. Supercharging of four-cycle engines is as follows:

(A) Partial supercharging systems

(1) Partial supercharging systems are used primarily on slow and medium speed engines. In one of the designs of this system the engine is fitted with a specially designed exhaust outlet (with a D-valve) and with a supercharging aggregate. Experiments conducted on ship engines have shown that with such a system a degree of supercharging of 1.2 can be reached. The basic defect of this system is the low degree of supercharging attained for the great amount of work involved in the conversion of the engine to the system. The other partial supercharge systems have not reached any degree of use on ships.

(2) The inertia system of supercharging occupies a special place among the other systems. In this system the increased pressure is attained in the end of the charging of the cylinder not by some type of supercharge aggregate but by the use of dynamic pressure created by the inertia of a stream of air in a suction pipe. In order to increase the inertia action of the air stream the following changes are made in the suction system:

(a) A profile is made of the cam disc of the suction valve in such a way as to create a greater vacuum in the first half of the suction stroke;

(b) A suction pipe of the maximum possible diameter and length is selected.

The inertia supercharge system works as follows: In the first part of the piston stroke in the working cylinder a considerable rarifying is created (up to 0.3 or 0.4 kg per square cm) due to the small amount of opening of the suction valve; at about the middle of the piston stroke this valve opens all the way; the stream of air rushing into the cylinder has a great velocity (up to 200 meters per second) and toward the end of the piston stroke it creates a dynamic pressure reaching 1.15 to 1.20 kg per square cm. Experiments conducted on different types of four-cycle engines have shown that this type of supercharger increases the average effective pressure about 25%. The best feature of this system is the absence of any kind of supercharge aggregate. Its basic disadvantages are that the supercharge pressures are lowered making for lower pressures at the end of compression and fewer rpms and that this type of supercharge requires an exhaust pipe of exceptional length, a circumstance which has limited the adoption of this device for ship engines. [redacted] five Diesel tugs of the "Neydtanker" Company were equipped with the inertia supercharger. [redacted] this system was adopted on only two Diesels but [redacted] it was planned that all tugs of this type would be fitted with the inertia supercharger. These Diesels were screw and paddle-wheel types ("Kapitan Kramovy", "Metallist", "Kolkhoznik", "Kommunar", and VLKSM-Diesels of the "Bayan" class), and Diesels built in the Krasnoye Sormovo factory. These ships each have two four-cycle Diesel engines of 450 hp and developing 235 rpm each. The engines are mounted on a parallel plane and the power is transmitted to the side paddle wheels thru an electro magnetic clutch. The use of inertia supercharging increases the horse power of each engine to 535-850 hp and the horse power of each power plant to 1070-1100 hp.

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(B) Full Supercharging Systems

(1) On four-cycle engines of the low-speed type a system has been adopted in which the cylinder cavity below the piston is used as a supercharge pump. In this case the lower cavity of the cylinder is enclosed in a light casing which is equipped with an assembly of automatic valves or with a valve layout thus forming a simple action supercharge piston pump. Air is sucked into the cavity from the surrounding atmosphere, compressed to 1.2-1.4 kg per sq cm and enters into the engine's manifold. Since the supercharge pump operates in two cycles and the engine is four cycle it is sufficient in a multicylinder construction to use only part of the lower cylinder cavities, depending on the amount of supercharge air required. For example, in a six-cylinder engine it is sufficient to have four supercharge pumps.

(2) In medium high-speed engines a full supercharge system is used which has a supercharge aggregate that operates directly off the engine. This system is used to produce pressures not higher than 1.6-1.7 kg per sq cm because in order to attain higher pressures the amount of engine power spent to operate the supercharge pump would be so great that the fuel consumption would be greatly increased (over 200 grams for one effective horse power per hour).

(3) The gas turbine supercharger has been adopted for the majority of four-cycle engines as the most effective. The gas turbine system (GTN) consists of the engine, the gas turbine and the centrifugal turbocompressor. The last two aggregates are actually built into one combined aggregate not attached kinematically to the engine. The system operates as follows:
The gases given off by the engine go out of the exhaust manifold into the gas turbine and set it in motion; air is drawn from the surrounding atmosphere and compressed in the turbocompressor putting the gas turbine in operation up to the supercharge pressure; from there the air goes to the intake valve of the engine. The supercharge pressure in this system is usually 1.3-1.6 kg per sq cm. The gas turbine system was designed originally by Reydtanker for use on the Diesel ice-breaker "Bogatir". This ship was received as reparations [redacted] and was assigned to transport work (as an oil barge tug) for the period when the water is not frozen and as an ice breaker for the period when the water is frozen. Two Diesel engines of the Doits type with a gas turbine supercharger were installed on this ship. The two engines together were supposed to develop 1100 hp. However, it turned out that the supercharger was not with the ship [redacted] so the ship actually developed only 900 hp. But with the help of the Astrakhan section of the All--Union Scientific Engineer-Technical Society a gas turbine supercharger was installed that restored and even slightly improved upon the original horse power (although only by 10-15 hp). The restoration of this ship was hindered by the fact that some parts of the plans of the ship (notably the engine plans) were missing.

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8. Supercharging of two-cycle engines is as follows: The use of the gases produced by the operation of an engine to drive a gas turbine compressor which is kinematically not connected to the engine has been limited up to recent times to four-cycle engines. Attempts to install such a supercharger failed because in order to get sufficient power to run the compressor the engine had to be loaded to 50% and more of the rated load. Besides, with this type of system it is impossible to start or operate the engine on low rpm's or with a light load because the gas turbine does not create sufficient pressure of supercharged air to accomplish the processes of exhaust and charging the operating cylinder. Four-cycle engines differ from two-cycle engines in that they can be started and operated on low rpm's by cutting off two "pump strokes" so that the necessary amount of air can be drawn in and the gas produced by combustion can be forced out. For this reason this development of the supercharging of two--cycle engines has been separate from the development of superchargers for four-cycle engines.

(1) Increased charging of the working cylinder

In the increased loading of the cylinder when air is to be used to increase the normal pressure and in order to raise the weight of the fuel charge the following construction measures are taken:

(a) In a transversal exhaust two rows of exhaust ports are used. Thru the upper row of exhaust ports, located higher than the outlets and closed by automatic valves, comes an additional quantity of exhaust air of a normal pressure (after the outlets are closed).

(b) In the loop-shaped slit exhaust a valve is placed on the outlet in order to close the port at the end of the outlet process and at the same time avoid loss of the charge.

(c) In engines with a straight line exhaust there is: Either a later closing of the exhaust ports on account of the uneven gas distribution, or a simultaneous closing of the exhaust and outlet organs. The above mentioned measures allow an increase in the weight of the charge of from 8-15%.

(2) Partial supercharging has not been widely used on two-cycle engines because of the increase in fuel consumption (5-10%) required for the operation of the supercharge pump (piston type).

(3) Full supercharging (the increase of pressure up to 1.5-2.5 kg per sq cm) makes it possible to increase pressure from one and a half to two and a half times the original pressure. This is the most effective type of supercharge. To operate with full supercharge on low rpm's and light load the following basic

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arrangements are made:

(a) The engine is equipped with a piston exhaust pump directly connected to the crankshaft and to the gas-releasing turbine transmitting its energy to the crankshaft thru a hydraulic coupling and a gear transmission. The hydraulic coupling is not absolutely necessary. Its purpose is to cut off the gas turbine during starting and operation on low rpm's. The basic defect of this system is the necessity of using the piston exhaust pumps and the inability to use the whole potential power of the gas turbine (because of its rigid connection to the engine.)

(b) The engine is equipped with a gas turbocompressor of about the same type as that used on the four-cycle engines, connected directly, however, with a gear transmission to the crankshaft. Owing to this connection a compressor of the centrifugal type carries out the exhaust and charging of the operating cylinder during the starting and operation on low rpm's. As far as load increase is concerned, the power of the gas turbine grows and when the engine is carrying a half load the power attains about the same point as that of the turbocompressor. The main defect in this system is the inability to increase the amount of air produced in one revolution of the engine on account of the kinematic connection between the gas turbocompressor and the engine.

(c) The third, more expedient method of supercharging two-cycle engines is by equipping the gas turbine aggregate with two couplings, the first coupling separating the gas turbine from the engine and the second separating the gas turbine from the turbocompressor. Thus, until a balance of power is attained between the turbine and the compressor the engine operates with the driving compressor (with the coupling between the engine and compressor connected) and with the turbine detached. After the powers are equalized, the coupling between the gas turbine and the turbocompressor is connected while the coupling between the engine and turbocompressor is disengaged, that is, the aggregate is not kinematically connected to the engine. Consequently, with this arrangement the engine can be started, operated on light loads and operated under supercharge, depending on the screw characteristic.

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